A HISTORY OF DARPA'S CONTRIBUTIONS TO ANTISUBMARINE WARFARE

By Joe Bousquin

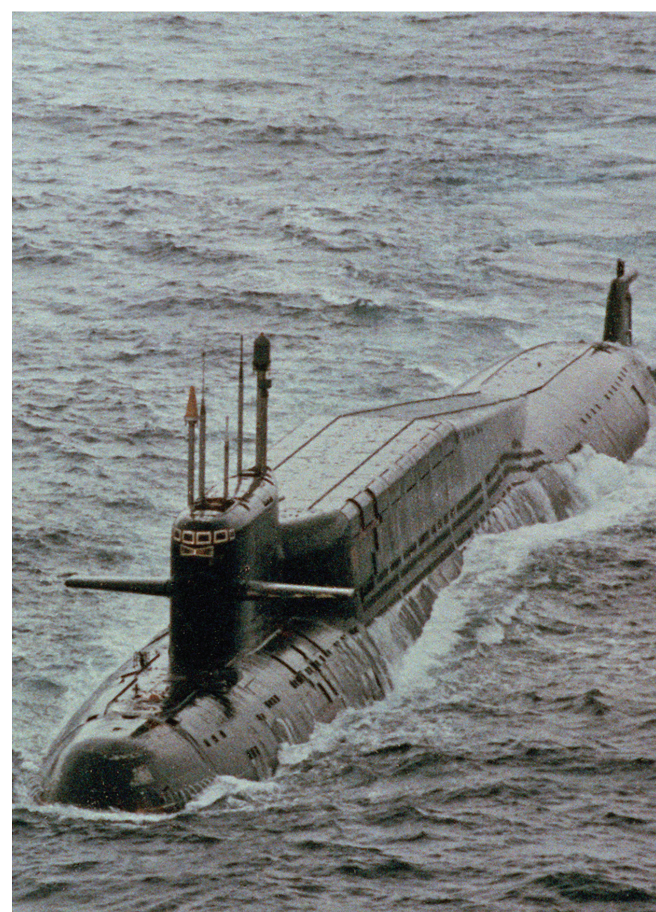
By the early 1970s, the U.S. Department of Defense (DoD) realized that its antisubmarine warfare philosophy needed to be updated. Namely, while the U.S. Navy had relied on a network of strategically placed ocean-floor sensors known as the Sound Surveillance System, or SOSUS, to track Soviet ballistic missile submarines leaving or returning to port since the late 1940s, those same subs were virtually invisible once they reached open water.

Without the technical or fiscal ability to blanket the entire ocean floor with SOSUS sensors, the system was only as good as its reach. That meant once a Soviet sub cleared predetermined "barrier" points in the North Atlantic or Pacific, it could roam the planet's waters freely – hauling its payload of nuclear weapons – with little fear of detection by U.S. forces.

With the blue water threat of free-ranging, nuclear-armed Soviet submarines coming to a head in 1971, the DoD assigned DARPA a singular mission: Revamp the U.S. military's antisubmarine warfare (ASW) sub-hunting capabilities to track enemy boomers under the open ocean, and do it fast. The ability to do so became even more important in the wake of the Strategic Arms Limitation Treaty, which allowed each side to deploy one submarine-based ballistic missile for every intercontinental ballistic missile silo it dismantled. That meant if the Soviets took down the sites for their known, aging nukes, they could replace them with missiles on highly elusive submarines that could lie just off America's shores.

At the time, the U.S. Navy was already working on what would become its Surveillance Towed Array Sensor System, or SURTASS, where surface ships towed long, mobile arrays of sensors to listen for submarine activity in a given area. Aimed at developing an ASW patrolling capability for the U.S. Navy, the goal of SURTASS was to ensure mobile tracking of enemy subs on a basin-wide scale, even after those subs ventured outside the fixed reach of the SOSUS net. But the Navy's program depended on telemetry to gain an accurate fix on enemy subs, and processing the massive amount of data gathered from the widespread arrays was a vexing challenge in the days before supercomputers and ultra-fast microprocessors.

Recognizing the data processing problem, researchers at DARPA responded to an elegantly simple – and extremely cost-effective – proposal from Henry Aurand of the Naval Ocean Systems Center. Why not experiment with off-the-shelf technologies already in use by oil exploration companies, which employed much simpler, though highly sensitive, seismic technologies to look for ocean-wide anomalies? If sensors



DARPA-enabled technologies that resulted from the LAMBDA and ARC projects helped U.S. defenses against Soviet submarines. During the Cold War, the U.S. Navy depended on the SURTASS system to detect and track Soviet submarines, like this Soviet Delta III-class ballistic missile submarine, once they had passed the fixed SOSUS sensors on the ocean floor.

DoD photos

DARPA's LAMBDA seismic technology kept the SURTASS towed sonar array in operation when the original telemetric system failed. The ocean surveillance ship (T-AGOS) USNS *Victorious* is one of the vessels equipped to deploy SURTASS. The projection at the stern of the ship is used to stream the towed array.

could be used to isolate seismic movement, couldn't they be used to isolate submarine movement as well? So was born the Large Aperture Marine Basic Data Array, or LAMBDA.

Then under the leadership of Dr. Stephen J. Lukasik, the agency put forth the first funds for the LAMBDA program on Dec. 2, 1971. Through ARPA order No. 2001, it rented a modified seismic towed array, and a fully equipped towing vessel to haul it, for a scant $100,000. With their array and ship in hand, DARPA-funded scientists began experiments at submarine depths, and soon turned in spectacular results.

Yet while the LAMBA tests were highly successful – and netted a joint program for further research with the Navy – SURTASS continued its telemetric approach. Then, in 1978, a massive failure in the complex telemetric system left SURTASS effectively dead in the water. With the proven ability of the LAMBDA seismic technology well tested at that point, Capt. Henry "Harry" Cox, a former DARPA program manager who was heading the Navy's program, quickly adopted LAMBDA's seismic approach for the remainder of the SURTASS development program. In 1981, the DoD gave quick approval for production of a LAMBDA-enhanced SURTASS array, without requiring further study, a highly unusual decision for a program that had experienced a late-developing, major technology shift. The system would become the Navy's go-to method for tracking mobile Soviet subs for the remainder of the Cold War. And while the Navy returned to the telemetry approach in SURTASS later, LAMBDA is largely credited for keeping the program alive – and hence, U.S. shores safe.

DARPA's contributions to ASW didn't stop on the high seas, though. On land, the agency was developing the computing power to process the data collected by arrays like LAMBDA, SURTASS, and SOSUS, so that submariners could track enemy subs in real time. The main hub for developing this processing power was DARPA's Acoustic Research Center (ARC), set up in 1974 at Moffett Field, Calif., during Dr. George Heilmeier's tenure as director. It was created as part of DARPA's SEA-GUARD program, an advanced ASW research project assigned to DARPA by the Director of Defense Research and Engineering in the mid-1970s. One of the key objectives at ARC was to process and correlate the tremendous amount of acoustic data collected by both fixed and mobile arrays, and make that information available to ships at sea.

Inspired by the use of a satellite link used on the commercial cruise liner *Queen Elizabeth*, ARC scientists experimented with a satellite feed to transmit data collected by LAMBDA arrays back to processing computers at ARC, and then correlated the feed with complementary SOSUS data to track enemy subs. The operation was part of the Fixed-Mobile Experiment, ARC's largest undertaking as a DARPA project.

By beaming the data back to Moffett Field, ARC could use state-of-the-art supercomputers, including the NASA-housed ILLIAC IV parallel processing mainframe, then one of the most powerful computers on the planet, to crunch the data into usable intelligence. Yet, even with the relative power of the ILLIAC IV, the sheer amount of data collected by LAMBDA and SOSUS resulted in continuous challenges to the system, and researchers pushed for other processing options. Turning inward, the ARC researchers employed technology already in use in their own backyard: the linked-together computers of the then-emerging ARPANET.

The elegance of the ARPANET's architecture was based on the fact that when it transferred information from one computer to the other, it did so by breaking that data down into digestible "packets," which were then put back together once all the information from a given data feed was received. The advantage was that if an information feed was interrupted in the middle of transmission, the remaining packets could be downloaded later, and joined together with the previously received data.

Making use of the packet-processing protocols upon which ARPANET had been built, ARC researchers linked 20 ARPANET computers together through a secure, "large band" link to process the acoustic signals gathered on the open sea. ARC's efforts to transmit and process formidable amounts of data pushed the limits of computer processing power and are credited with spurring industry development of faster microprocessors. The ARC project was rolled into the Naval Ocean Systems Center as an ongoing technology project in 1982.

As the Cold War continued to escalate through the 1980s, DARPA-enabled technologies that came out of the LAMBDA and ARC projects helped give U.S. forces an edge over the silent threat of Soviet submarines. By 1985, Secretary of the Navy John Lehman was so confident in his force's ability to keep tabs on elusive Soviet boomers he declared he would attack Soviet subs "in the first five minutes of the war." The ability to make that statement, and back it up with actual, tested technology, wouldn't have been possible without DARPA's contributions to the art of antisubmarine warfare.